Claims

1. A semiconductor structure comprising:

a semiconductor substrate;

a dielectric layer comprising lanthanum, aluminum, oxygen, and nitrogen over the semiconductor substrate; and

an electrode layer over the dielectric layer.

2. The semiconductor structure of claim 1, further comprising an interfacial layer between the semiconductor substrate and the dielectric layer.

3. The semiconductor structure of claim 2 wherein the interfacial layer comprises silicon, nitrogen, and oxygen.

4. The semiconductor structure of claim 2 wherein the interfacial layer comprises aluminum, nitrogen, and oxygen.

5. The semiconductor structure of claim 1 wherein a concentration of nitrogen in the dielectric layer is higher adjacent the electrode layer as compared to adjacent the semiconductor substrate.

6. The semiconductor structure of claim 1 wherein the dielectric layer is amorphous.

7. The semiconductor structure of claim 1 wherein the semiconductor substrate is selected from a group consisting of monocrystalline silicon, gallium arsenide, semiconductor on insulator, silicon germanium, and germanium.

8. The semiconductor structure of claim 1, wherein the electrode layer is a gate electrode.

9. The semiconductor structure of claim 1 wherein at least one element of the dielectric layer is graded from zero to a predetermined amount greater than zero.

10. A semiconductor structure comprising:

a first conductive layer;

a dielectric layer comprising lanthanum, aluminum, oxygen, and nitrogen over the first conductive layer; and

a second conductive layer over the dielectric layer.

11. The semiconductor structure of claim 10, wherein the first conductive layer is a floating gate.

12. The semiconductor structure of claim 10, wherein at least one of the first conductive layer and the second conductive layer is a capacitor plate.

13. The semiconductor structure of claim 10, wherein the dielectric layer has a concentration of nitrogen which is higher in a center portion of the dielectric layer as compared to portions adjacent both the first conductive layer and the second conductive layer.

14. A semiconductor structure comprising:

a semiconductor substrate;

a first dielectric layer formed over the semiconductor substrate;

a second dielectric layer comprising lanthanum, aluminum, oxygen, and nitrogen formed over the first dielectric layer; and

an electrode layer over the dielectric layer.

15. The semiconductor structure of claim 14 wherein the first dielectric layer is less than approximately 10 angstroms (1 nanometer) thick, and the second dielectric layer is between approximately 20-90 angstroms (2-9 nanometers) thick.

16. The semiconductor structure of claim 15 wherein the first dielectric comprises one of silicon oxide, oxynitride, and aluminum oxide.

17. The semiconductor structure of claim 14 wherein the first dielectric layer is between approximately 10-90 angstroms (1-9 nanometers) thick, and the

second dielectric layer is between approximately 5-20 angstroms (0.5 to 2 nanometers) thick.

18. The semiconductor structure of claim 17 wherein the first dielectric layer has a dielectric constant (κ_ε) in excess of 5.

19. A method for forming a semiconductor structure comprising:

providing a first material selected from a substrate having a semiconductor surface and a conducting layer

forming a dielectric layer comprising lanthanum, aluminum, oxygen and nitrogen over the first material; and

forming a conductive electrode layer over the dielectric layer.

20. The method of claim 19 wherein forming a dielectric layer comprises:

forming a dielectric layer comprising lanthanum, aluminum, and oxygen which is substantially free of nitrogen; and

incorporating nitrogen into the dielectric layer.

21. The method of claim 20 wherein incorporating nitrogen comprises exposing the semiconductor structure to ammonia gas (NH_3).

22. The method of claim 20 wherein incorporating nitrogen comprises introducing a remote nitrogen (N_2) plasma during deposition of the dielectric layer.

23. The method of claim 19 wherein nitrogen concentration at a location within the dielectric layer is between 1.0 and 10 atomic percent.

24. The method of claim 19 wherein forming the dielectric layer comprises forming the dielectric layer by atomic layer chemical vapor deposition (ALCVD).

25. The method of claim 24 wherein forming the dielectric layer comprises:

forming a first monolayer comprising aluminum and oxygen;

forming a second monolayer comprising lanthanum and oxygen; and

forming a monolayer of nitrogen onto at least one of the first monolayer and the second monolayer.

26. The method of claim 25 wherein forming a monolayer of nitrogen is achieved using ammonia (NH_3) gas.

27. The method of claim 25 wherein forming a monolayer of nitrogen is achieved using nitric oxide (NO) gas.

28. The method of claim 25 wherein forming a monolayer of nitrogen is achieved using a remote nitrogen (N_2) plasma.

29. The method of claim 19 wherein forming a dielectric layer comprises forming the dielectric layer using organometallic chemical vapor deposition.

30. The method of claim 29 wherein nitrogen is incorporated into the dielectric layer by use of a nitrogen containing gas selected from a group consisting of ammonia gas (NH_3); nitric oxide gas (NO), and nitrous oxide gas (N_20).

31. The method of claim 29 wherein nitrogen is incorporated into the dielectric layer by using a remote nitrogen (N_2) plasma.

32. The method of claim 19 wherein the step of forming a dielectric layer comprises form a dielectric layer wherein a concentration of nitrogen within the dielectric layer is higher adjacent the conductive electrode layer as compared to adjacent the first material.

33. The method of claim 32 wherein the concentration of nitrogen adjacent the first material is less than 0.5% atomic percent.

34. The method of claim 32 wherein the concentration of nitrogen adjacent the conductive electrode layer is greater than 1.0% atomic percent.

35. The method of claim 19 wherein the step of forming a dielectric layer comprises forming a dielectric layer wherein a concentration of nitrogen within the dielectric layer is higher in a center portion of the dielectric layer as compared to both a portion adjacent the conductive electrode layer and a portion adjacent the first material.

36. The method of claim 19, wherein the step of forming a dielectric layer comprises performing physical vapor deposition.

37. The method of claim 36, wherein the step of performing physical vapor deposition comprises pulsed laser deposition by pulsing a laser beam onto a lanthanum aluminate target in an active nitrogen ambient.

38. The method of claim 19 further comprising depositing an insulating layer between the first material and the dielectric layer.

39. The method of claim 38, wherein the insulating layer comprises one of either silicon oxide, oxynitride, and aluminum oxide.

40. The method of claim 38 wherein the insulating layer has a dielectric constant greater than 5.

41. A semiconductor structure comprising:

a semiconductor substrate;

a dielectric feature comprising lanthanum, aluminum, and oxygen over the semiconductor substrate.

42. The semiconductor structure of claim 41, wherein the dielectric feature further comprises nitrogen.

43. The semiconductor structure of claim 42, wherein the dielectric feature consists of nitrided lanthanum aluminate.

44. The semiconductor structure of claim 42, wherein the dielectric feature comprises one of a gate dielectric, an etch stop layer, a trench liner, and a sidewall spacer liner.

45. The semiconductor structure of claim 42, wherein the dielectric feature functions as a diffusion barrier.